

Attorney Docket No.: MTRL020US0 (SC12589TP)

PATENTS  
Customer No. 37,141

REMARKS:

The Examiner's indication of allowability with respect to claim 20 is gratefully acknowledged. Claim 20 has been rewritten with this response as new claim 22.

The Examiner's comment with respect to the Information Disclosure Statement (IDS) is noted. A supplemental IDS is included herein, along with the inadvertently omitted reference and the fee set forth in § 1.17(p).

Reconsideration of the Examiner's rejection of claims 2-4, 6, 9, 15-17 and 19-20 under 35 U.S.C. 112, second paragraph, is respectfully requested.

Claim 2 has been amended with this response in accordance with the Examiner's suggestion. It is thus respectfully submitted that the Examiner's rejection of claims 2-4 has been overcome.

Claims 6 and 19 have been amended with this response to clarify the reference to the hydrocarbon surfactant. It is thus respectfully submitted that the Examiner's rejection of claims 6 and 19 has been overcome.

Claim 9 has been amended with this response in accordance with the Examiner's suggestion. It is thus respectfully submitted that the Examiner's rejection of claim 9 has been overcome.

Claim 15 has been amended with this response in accordance with the Examiner's suggestion. It is thus respectfully submitted that the Examiner's rejection of claims 15-17 has been overcome.

Claim 20 has been amended with this response so that it is dependent from claim 18 instead of claim 19. Claim 20 has also been amended with this response to supply the chemical name for the abbreviation "EGMBE". It is thus respectfully submitted that the alleged indefiniteness relating to the numerical range and the claim terminology has been eliminated.

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Reconsideration of the Examiner's rejection of claims 1-3, 6, 8, 12, 14-16 and 18-19 under 35 U.S.C. 102(b) as being anticipated by Robinson et al. (U.S. 6,103,627) is respectfully requested.

The claims have been amended with this response to recite that the processing residues are organometallic and polymeric in nature. The Examiner has conceded (in his rejection of claim 4) that Robinson et al. does not teach the removal, with the solutions described therein, of residues that are organometallic and polymeric in nature. Accordingly, as amended, the claims are not anticipated by Robinson et al. For the sake of completeness, however, the Examiner's rejection of some of the dependent claims are discussed below, since these rejections do not appear to be valid.

With respect to claim 3, the Examiner argues that Robinson et al. teaches a semiconductor device that has at least one opening with processing residues on the surface thereof which were formed during the creation of the opening. The Examiner points to FIG. 2 and to Col. 5, Lines 25-55 of Robinson et al. in support of this contention. However, contrary to the Examiner's assertion, the only processing residues noted in the cited portion of Robinson et al., or anywhere else in the reference for that matter, are the silicon dioxide particles formed during chemical mechanical polishing. See, e.g., Col. 5, Lines 38-40. Notably, the chemical mechanical polishing step described in Robinson et al. occurs *after* formation of space 16 in the structure shown in FIG. 2 of the reference. Hence, to the extent that these particles qualify as processing residues, they are residues that were formed *after* creation of the opening. By contradistinction, claim 3 requires that the processing residues be formed *during* formation of the opening.

With respect to claims 16 and 18, Applicant notes that, as with claim 3, the processing residues described in Robinson et al. are not formed during the etching process used to define the openings, but are formed during the subsequent chemical mechanical polishing step.

Reconsideration of the Examiner's rejection of claim 4 under 35 U.S.C. 103(a) as being unpatentable over Robinson et al. (U.S. 6,103,627) in view of Lee et al. (U.S. 6,825,156) is respectfully requested.

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As a preliminary matter, it should be noted that Lee et al. is directed to a class of cleaning materials known as hydroxylamines. Such materials are specifically discussed in the background section of the present application at Paragraph [0003]. There, it is noted that

Many attempts have been made in the art to remove these [organometallic polymeric] processing residues from vias through the use of various cleaning formulations, so that the aforementioned problems will not be encountered. However, such cleaning formulations frequently cause complications of their own. For example, strong organic solvents such as hydroxylamine (HDA) have often been used to remove these residues, but the use of such solvents is expensive, hazardous, environmentally unfriendly, and often requires processing times that are longer than desired. Moreover, most solvent systems based on a single solvent or a small number of solvents are ineffective at removing all components of such residues from vias, given the complex chemistry of these residues. [emphasis added]

The micellar solutions of the present invention are designed as an alternative to cleaning solutions based on hydroxylamines. In contrast to the hydroxylamine solutions disclosed in Lee et al., the solutions of the present invention are non-toxic, environmentally friendly, inexpensive, and non-hazardous, and are remarkably effective at removing the various components of the organic metallic polymeric residues commonly formed during the via etching of substrates that contain metal interconnects. These advantages of micellar solutions are neither taught nor suggested by any of the references cited by the Examiner.

Turning now to the specifics of the Examiner's rejection, the Examiner concedes that Robinson et al. does not disclose the use of the solutions described therein for the removal of organometallic polymer residues, but relies on Lee et al. for this teaching. However, Lee et al. also fails to teach the use of micellar solutions in removing organometallic polymeric residues. Rather, as previously noted, Lee et al. merely teaches the well-known use of hydroxylamines for this purpose. Since a proposed combination of references must teach or suggest each and every element of a claimed invention in order to render a claimed invention obvious, and since the proposed combination of Robinson et al. with Lee et al. fails to teach or suggest the use of micellar solutions to remove organometallic polymeric processing residues, this proposed combination of references does not render the claimed invention obvious.

Moreover, even if it is assumed that Lee et al. does at least teach the removal of organometallic polymer residues with the solutions described therein, one skilled in the art would

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have no incentive to combine the references as the Examiner suggests because, *inter alia*, if one skilled in the art wanted to remove organometallic polymeric residues from a semiconductor device, one skilled in the art would simply use the solution of Lee et al. to do so. The only suggestion that removal of these residues may be effected through the use of micellar residues in a non-toxic, environmentally friendly, inexpensive, and non-hazardous manner is found within the four corners of the present application. However, the Examiner is respectfully reminded that he may not rely on hindsight in construing the prior art.

For the sake of completeness, Applicants acknowledge that Lee et al. does teach that the solutions described therein may contain a surfactant (Col. 17, Lines 35-37). However, there is no indication in Lee et al. that the surfactant should be used as a micellar solution. To the contrary, surfactants are typically used to reduce surface tension in a solution, and do not have to be present at the critical micelle concentration to serve this function. Moreover, not all surfactants form micellar solutions and, of those that do, such solutions are achieved under a narrow range of conditions. Also, it is not clear that use of a surfactant as a micellar solution would make any difference in the solutions of Lee et al., since those solutions rely primarily on the chemistry of polyfunctional hydroxylamines for their cleaning power. Hence, even if Robinson et al. can be fairly construed to teach micellar solutions, the combination of Robinson et al. and Lee et al. still does not render the presently claimed invention obvious.

Finally, Applicant notes that the process of Robinson et al., while arguably involving a micellar solution, also involves treatment of the substrate with dilute HF (DHF). As noted in Paragraph [0005] of the present application (taken in light of paragraph [0001]), the use of DHF is undesirable in BEOL processes, due to its tendency to corrode metal layers and undercut underlying barrier layers, thus resulting in dielectric lift-off. Hence, the Examiner has not established that the combination of Robinson et al. and Lee et al. would be desirable as required for a finding of obviousness, especially when metal layers are present (see, e.g., claim 27). By contrast, the process disclosed in the present application avoids the need for DHF.

Reconsideration of the Examiner's rejection of claims 5, 9, 13, 17 and 21 under 35 U.S.C. 103(a) as being unpatentable over Robinson et al. (U.S. 6,103,627) in view of Aoki (U.S. 6,423,148) is respectfully requested.

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Applicants respectfully note that this rejection has been rendered moot by the amendments to the claims. In particular, the rejected claims, as amended, specify that the residues are organometallic. The Examiner has correctly recognized that Robinson et al. neither teaches nor suggests the use of the solutions described therein for the removal of such residues. Since Aoki also lacks such a teaching, the rejected claims, as amended, are patentable over this combination of references.

Reconsideration of the Examiner's rejection of claim 11 under 35 U.S.C. 103(a) as being unpatentable over Robinson et al. (U.S. 6,103,627) in view of Bessho et al. (U.S. 6,440,856) is respectfully requested.

Applicants respectfully note that this rejection has been rendered moot by the amendments to the claims. In particular, the rejected claims, as amended, specify that the residues are organometallic. The Examiner has correctly recognized that Robinson et al. neither teaches nor suggests the use of the solutions described therein for the removal of such residues. Since Bessho also lacks such a teaching, the rejected claims, as amended, are patentable over this combination of references.

Reconsideration of the Examiner's rejection of claims 7 and 10 under 35 U.S.C. 103(a) as being unpatentable over Robinson et al. (U.S. 6,103,627) in view of De Young et al. (U.S. 6,641,678) is respectfully requested.

Applicants respectfully note that this rejection has been rendered moot by the amendments to the claims. In particular, the rejected claims, as amended, specify that the residues are organometallic. The Examiner has correctly recognized that Robinson et al. neither teaches nor suggests the use of the solutions described therein for the removal of such residues. Since De Young et al. also lacks such a teaching, the rejected claims, as amended, are patentable over this combination of references.

With respect to new claims 22-28 that have been added with this response, Applicants note that these claims find support in the claims as originally filed. Claim 22, from which claims

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23-28 depend, contains the subject matter of original claim 20, which was deemed allowable by the Examiner.

With respect to new claim 29 added with this response, Applicant notes that support for this claim can be found, for example, in Paragraph [0014] taken in light of Paragraph [0003] of the present application. This claim is patentable over the art cited by the Examiner because it requires that the micellar solution be devoid of hydroxylamine solvents, and the art cited by the Examiner (specifically, Lee et al.) is specifically directed toward such solvents. In contrast to micellar solutions, hydroxylamine solvents are toxic, environmentally unfriendly, expensive, and hazardous.

The Commissioner is hereby authorized to charge any fees due with this response, including those noted in the cover sheet, to the deposit account of FORTKORT GRETHER KELTON LLP, Deposit Account No. 50-2726.

Respectfully submitted,

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